INTEGRATED HYDRAULIC SYSTEM FOR MOTOR VEHICLES

BACKGROUND OF THE INVENTION

[0001] 1. Technical Field:

[0002] The invention relates to hydraulic power take off systems for motor vehicles and more particularly to a modularized, hydraulic power takeoff system integrated with a vehicle's controller area network.

[0003] 2. Description of the Problem:

[0004] Contemporary trucks are often equipped for power takeoff operation (PTO). PTO systems are auxiliary systems, such as hoists, lifts, and pumps that are directly or indirectly powered by the vehicle's engine. Indirectly powered systems, such as hydraulic systems, are among the most popular. Power for an auxiliary hydraulic system is converted from engine output by an engine driven hydraulic pump. The hydraulic pump draws working fluid from a tank and supplies fluid to a hydraulic valve manifold which can divert the working fluid to a cylinder or impeller used to move a target load.

[0005] Although original vehicle manufacturers have supplied general purpose hydraulic pumps with vehicles suitable for supporting hydraulic power take off operation, the provision of controls and hydraulic lines has generally been left to after market specialists. Such controls have been retrofitted to vehicles, typically by the addition of wiring and hydraulic lines. Integration with other vehicle systems has been poor and the location of hydraulic tanks and modification of vehicle body systems can compromise owners' chassis warranties. Nor have these accessories been as reliable, light weight, or small as possible, nor have they conveniently provided as much power as can be required without modification of a vehicle's hardware.

SUMMARY OF THE INVENTION

[0006] According to the invention there is provided a vehicle system integrated hydraulic power take off system utilizing modular components and requiring minimum modification of the vehicle. Modular units of the system include an hydraulic fluid tank, a hydraulic valve manifold, an engine driven pump, and a switch and instrument panel. Further provided are a hydraulic valve controller and an auxiliary gauge and switch controller both of which provide for connection to a vehicle controller area network for integrating hydraulic system operation with vehicle operation. Most components of the system can be adapted from off the shelf components to minimize cost. The hydraulic fluid tank is preferably adapted from a fuel tank for mounting in conventional strap on fashion to a truck frame side rail. Control protocols are adapted from standard SAE J-1939 bus signals. The valve manifold may be mounted to the reservoir tank. Other vehicle controllers are monitored for standard signals for implementing interlocks. The engine controller may be invoked to increase engine output.

[0007] Additional effects, features and advantages will be apparent in the written description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

[0009] **Fig. 1** is a side elevation truck with an hydraulic power takeoff operation system.

[0010] **Fig. 2** is a perspective view of a combination fuel tank and hydraulic fluid reservoir suitable for attachment to a truck's siderail.

[0011] **Fig. 3** is a front elevation of a control panel for the power takeoff operation system of the invention.

[0012] **Fig. 4** is a schematic of a preferred embodiment of the present invention.

[0013] **Fig. 5** is a control schematic for a hydraulic valve manifold utilized with the present invention.

[0014] **Fig. 6** is a flow chart of a control program for the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring now to the figures and particularly to **Fig. 1**, a preferred embodiment of the invention will be described. A truck **12** is adapted for service as a wrecker. A driver usually controls the vehicle from a cab **16** positioned in the forward portion of the vehicle. An auxiliary system, including a winch **20**, is positioned over the vehicle siderails **22** and the rear wheels **14**. Winch **20** may be used to tow a vehicle onto a pivotable extendable bed **24** for transport of the vehicle. The winch **20** is illustrated as being controlled from a panel **18** located just aft of cab **16**. Panel **18** may alternatively be located inside cab **16**. Panel **18** includes switches for controlling operation of the auxiliary system and gauges indicating values for hydraulic PTO system operating variables. A combined fuel tank/hydraulic fluid reservoir **24** is located under cab **16** mounted from siderail **22**. While it is contemplated that the invention be applied to vehicles having internal combustion engines, it is not restricted to such vehicles. The auxiliary systems used may take any one of a number of forms, with the shared characteristic being that a hydraulic power takeoff operation system is used to operate the auxiliary system.

[0016] **Fig. 2** illustrates a combined fuel tank/hydraulic fluid reservoir **26** utilized with a preferred embodiment of the invention. While a combined tank is shown, the invention may be implemented using a stand alone hydraulic fluid reservoir if desired. Whichever is used, the overall tank should have dimensions corresponding to those for

a standard strap on saddle tank for a truck. Combined tank **26** includes a forward fuel tank **28** and an aft hydraulic fluid reservoir **30**. Depending from the rear face of tank **26** is a hydraulic valve manifold **34**, from which extend a plurality of hydraulic line connection points **38**. A valve controller **40** is located adjacent hydraulic valve manifold **38**. A return filter **36** is located on top of hydraulic fluid reservoir **30** with a conduit **42** connecting the reservoir to return filter. Combined tank **26** is attached by straps **32** to a truck frame siderail (shown above). The hydraulic pump is not shown here but is schematically illustrated in **Fig. 4**.

[0017] Referring now to **Fig. 3**, a control and instrument panel **18** suitable for implementing control over a hydraulic power takeoff operation system and associated vehicle auxiliary system is illustrated. While panel **18** is typically mounted on a vehicle, it may be installed on a radio controlled remote unit. Three gauges are provided including a system pressure gauge **70**, an hydraulic fluid temperature gauge **72** and an hydraulic fluid level gauge **74**. The gauges may incorporate warning lights to draw operator attention to out of norm operating conditions. Six three way rocker switches **76**, **78**, **80**, **82**, **84** and **86** are also provided, which may be labeled as required for the particular application of the system. Association of the switches with a particular function is implemented in software and labeling of the switches as desired will typically follow. In a preferred embodiment suitable for use with a wrecker, switch **76** is an up/down enable switch. Each switch may incorporate a light, the operation of which may be programmed to indicate system availability or state of the switch.

[0018] **Fig. 4** illustrates a vehicle electrical control system **10** incorporating required elements to implement a hydraulic PTO system **44**. Hydraulic PTO system **44** is directed to controlling loads **48**, which correspond to the auxiliary systems mounted on vehicle **12**, by directing pressurized hydraulic fluid to the loads from a valve pack manifold **34** as part of a circulating hydraulic fluid circuit, i.e. hydraulic PTO system **44**. Hydraulic fluid circulates through the hydraulic circuit or PTO system **44** from valve pack manifold **34** to return filter **36**, then to a tank or reservoir **30** from which fluid is drawn and pressurized by a pump **50** for return to the valve pack manifold. Valve positions in valve pack manifold **34** are controlled by a valve system controller **40**, which includes solenoids to physically move the valves, and which monitors the hydraulic fluid level in

reservoir **30** and the system oil pressure and temperature from manifold **34**. Return filter **36** condition is indicated by the pressure drop across the filter which is reported by a sensor to valve system controller **40**, which reports the need for maintenance to ESC **62**.

[0019] Pump **50** is powered by vehicle engine **52** through a mechanical linkage **54** to the engine crankshaft (not shown). PTO operation may be enhanced by utilizing an engine control unit (ECU) **58** which monitors engine operating variables using engine sensors **56**. While engine sensors **56** are illustrated as being direct intermediaries between ECU **58** and engine **52**, related instruments, such as a tachometer, may in fact be connected to the transmission **65** with the resulting signal provided directly to the ECU or indirectly to the ECU through a transmission controller **64** over controller area network (CAN) bus **60**. Integration of the components is preferably provided by a program resident on and executed by an electrical system controller (ESC) **62** and communicating with other controllers over CAN bus **60**. As previously suggested, CAN bus **60** conforms to the SAE J1939 standard. Communication between a valve system controller **40** and an auxiliary gauge and switch package (AGSP) **68** to an operator interface (i.e. panel **18**) is provided by CAN bus **60**. CAN bus **60** typically provides a physical backbone comprising a twisted pair (either shielded or unshielded) cable operating as a data link or serial data bus. ESC **62** manages the assorted vocational controllers (e.g. valve system controller **40** and ECU **58**) connected to bus **60** as nodes. ESC **62** may also execute a load management program which oversees the total load imposed on the vehicle electrical system and power train by various accessories installed on the vehicle.

[0020] The SAE J1939 protocol defines a number of messages which may be readily adapted to serve the requirements of a hydraulic PTO system. The auxiliary gauge and switch pack controller **68** allows hydraulic system information to be easily and conveniently displayed to the operator.

[0021] Modularity is achieved in part by providing a combined tank **26** which mounts in a standard location and by standard components used for a conventional, if oversized fuel tank; divided into a fuel tank and an oil reservoir. Attachment of the valve

manifold **34** and valve system controller **40** to tank **30** offers a particularly advantageous location for these components standardizing the connection between the components and the tank. Control is readily implemented using a conventional instrument cluster (panel **18**) connected communicating with the required devices over a conventional CAN bus **60**. Pump **50** is readily mounted in a standardized location on engine **52** using a predetermined bracket set. The only non-standard components from one application to another should hydraulic lines, other than those to the engine mounted pump **50**, and minor programming changes.

[0022] Referring to **Fig. 5**, the circuit of hydraulic system **44** is illustrated in greater detail. Valve pack manifold **34** conventionally provides a total of six, four way, three position valves, here connected for supporting operation of a truck configured as a wrecker and connected to assorted hydraulic actuators. A first valve **90** is connected to a roll control cylinder **91**, a second valve **92** is connected to a bed tilt control cylinder **93**, a third valve **94** is connected to a boom extension cylinder **95**, a fourth valve **96** is connected to a boom retraction (IRL) cylinder **97**, a fifth valve **98** is connected to a first bed winch impeller **99** and a sixth valve **100** is connected to a second bed winch impeller **101**. Reservoir **30** collects hydraulic fluid from valve manifold **34** from which it is drawn by pump **50**. Impellers **99** and **101** are optimized to operate at different system pressures. Diverter valves **105** and **107** provide pressure control. Pump **50** in one embodiment is an engine driven pump providing 12 gallons per minute flow at 3000 psi. Each valve is rated for a maximum flow of 10 g.p.m.

[0023] Program control of the hydraulic PTO system of the present invention may be distributed among the assorted controllers of the vehicle's electrical control system, but is preferably resident in and primarily executed on the ESC **62**. Referring to **Fig. 6** a flow chart illustrates a representative sequence of steps taken to implement network control over PTO. Execution of the program is initialized by closure of an enable switch **110**, placing transmission **65** into neutral and engaging the parking brake **66**. Transmission controller **64** reports the position of the transmission at interrogatory step **112** and the ESC **62** determines the position of the parking brake at interrogatory step

116. Determination that either condition is not met, after engaging the enable switch, results in flashing an indicator light on the vehicle instrument panel for the indicated device on and off, as indicated at steps **114** and **118**, following NO branches from the interrogatory steps **112** and **116**, respectively. Steps **112** and **116** are looped so that once the indicated steps are taken with the parking brake and transmission program execution is allowed to proceed. If the transmission is in neutral, and the parking brake is engaged, an interlock switch is set. In the flow chart the notation "return" or "loop" indicates a return to step **112** while "continue" indicates a continued execution following the opposite branch from the most recent execution division or at the step indicated.

[0024] Continued operation of the hydraulic PTO system may be programmed to depend upon working fluid condition related variables, namely hydraulic oil temperature, hydraulic oil level and system pressure, all falling within certain limits. Decision steps **120**, **124** and **128** indicate compiling of the three variables and the generation of flashing warning lights at steps **122**, **126** and **130** following the NO branches from the decision steps. In the preferred embodiment, when oil temperature meets or exceeds 220EF, oil level falls below 50% of the desired level, or system pressure meets or exceeds 3000 psi, warning lights are flashed. All conditions are periodically monitored by looping through the decision steps.

[0025] Steps **180** to **183** represent determination of PTO power setting if the interlock switch is set by engagement of the parking brake and positioning of the transmission in neutral. If the interlock is engaged and the enable switch up (typically the first switch, i.e. switch **76** on panel **18**) indicating operations involving moving a vehicle on, off, or into position for loading onto a wrecker (step **181**), PTO power is set to 100% using the enable solenoid. If the enable switch is down (step **182**) power is set to 50% reflecting the lesser power requirements for paying out the hoist, rewinding the hoist or repositioning the bed without a vehicle. Execution then continues with scanning changes in position of each of the remaining five switches on panel **18**.

[0026] Steps **132** and **136** reflect actions (lowering and raising the wrecker bed, steps **134** and **138**, respectively) taken in response to switch **78** (#2) being moved to the up and down positions. Steps **140** and **144** reflect actions (extending and retracting the wrecker bed, steps **142** and **146**, respectively) taken in response to switch **80** (#3) being moved to the up and down positions. Steps **148** and **152** reflect actions (wheel lift up and wheel lift down, steps **150** and **154**, respectively) taken in response to switch **82** (#4) being moved to the up and down positions. Steps **156** and **160** reflect actions (extending wheel lift and retracting wheel lift, steps **158** and **126**, respectively) taken in response to switch **84** (#5) being moved to the up and down positions. Finally, movement of switch **86** on panel **18**, relating to winch operation, is determined at steps **164** (up) and **173** (down). Winch operation is made dependent upon system hydraulic pressure and accordingly several decision steps are involved before particular solenoids are actuated. Where switch **86** is up, step **166** is executed to determine system pressure. If system pressure exceeds 2000 psi winch **20** is wound by actuating the solenoid for valve **98**. If system pressure is less than 2000 psi, winch **20** is wound by actuating the solenoid for valve **100** and simultaneously raising engine rpms by 1500 to boost system pressure (steps **166**, **168**, **170** and **172**). Similarly, when switch **86** is down, system pressure is checked (step **175**). If pressure is greater than 2000 psi the winch is unwound with actuation of the solenoid for valve **98** (step **176**). If hydraulic system pressure is less than 2000 psi, the solenoid for valve **100** is actuated (step **174**) and a request to raise engine rpm 1500 is made (step **170**). Requests for boosts in engine output are passed to engine controller **58**. It will be understood that a change in system pressure results in a shift in operation from one valve to the other.

[0027] The invention provides the components for implementing a modularized power take off system which may be installed on a truck with minimum modification to the vehicle, either on the assembly line or as an accessory at the dealer. The modular power units are adapted to attach to a convenient point in the vehicle and for communication after connection to a vehicle control system. Hydraulic power takeoff is standardized. Power take off systems in accordance with the invention are non-the-less fully integrated with a motor vehicle control system for efficient operation supported by

the vehicle's prime mover.

[0028] While the invention is shown in only one of its forms, it is not thus limited but is susceptible to various changes and modifications without departing from the spirit and scope of the invention.